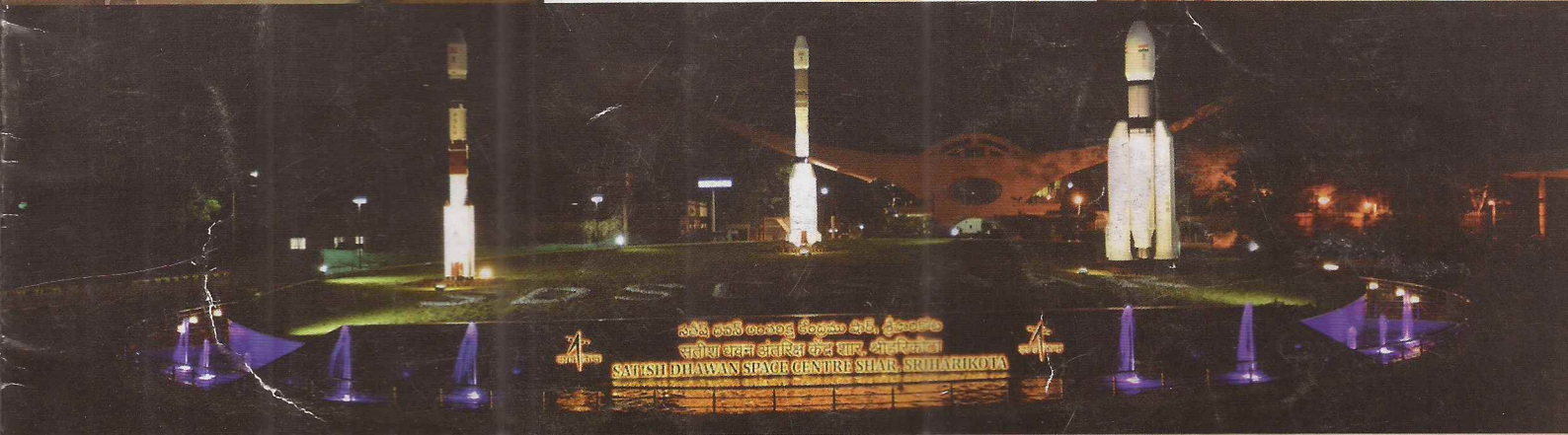




Spaceport of India



Satish Dhawan Space Centre SHAR
Sriharikota

Spaceport of India

Satish Dhawan Space Centre SHAR (SDSC SHAR), Sriharikota, the Spaceport of India, is one of the lead centres of Indian Space Research Organisation (ISRO), Department of Space (DOS), Government of India. The Centre provides world class launch base infrastructure for national and international customers in accomplishing diverse launch vehicle/satellite missions for remote sensing, communication, navigation & scientific purposes and is one among the best known names of the Spaceports of the world today.

The genesis of SDSC SHAR can be traced back to 1960s when the great visionary Dr. Vikram A Sarabhai embarked upon space research activities in the country and envisioned that "we must be second to none in the application of advanced technologies to the real problems of man and society". To venture on the indigenous development of satellites and their launch vehicles, it was decided to set up a rocket launch station on the East Coast of our country, far from populated areas. Situated on the East Coast (advantage from earth rotation), largely un-inhabited area, sandwiched between Pulicat Lake and Bay of Bengal, far from populated areas and a very long azimuth corridor for various Indian Space Missions - all these geographical parameters have made Sriharikota the ideal location for the spaceport. It became operational on October 9, 1971 with the flight of 'Rohini-125', a small sounding rocket. During these 47 years, the infrastructure at SDSC SHAR was developed in a phased manner catering to the needs of various launch vehicles, viz., SLV, ASLV, PSLV, GSLV and GSVL-MkIII.

The Space Centre, which was popularly known as SHAR (Sriharikota Range), was renamed as 'Satish Dhawan Space Centre SHAR' on 5th September, 2002, in fond memory of Prof. Satish Dhawan, former Chairman of Indian Space Research Organisation (ISRO). It covers an area of about 43,360 acres (175 sq.km) with a coastline of 50 km. Eucalyptus, casuarina plantation, scrub jungle vegetation (including a few medicinal herbs), groves of coconut & palm and cane brakes around shallow fresh water ponds dominate the landscape of Sriharikota. To offset the increased usage of land and to balance the nature, simultaneous action of forest regeneration have been contemplated and implemented in right earnest. All these measures have helped in the conservation of both flora and fauna of Sriharikota.

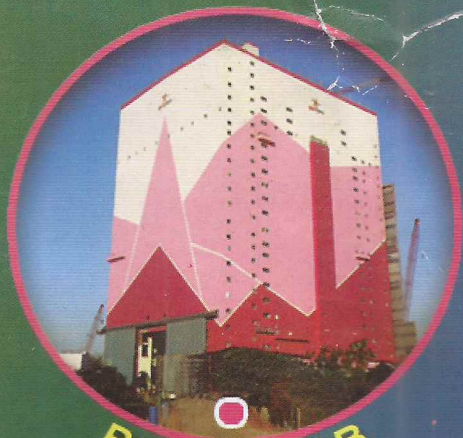
The first Indian Lunar Mission, Chandrayaan-1, the first Interplanetary Mission of India, Mars Orbiter Mission (MOM), launching of 104 satellites in one mission, launching of satellites in different orbits in one mission, the maiden flight of GSLV-MkIII-D1, etc., were flown from here apart from other missions. The launch of PSLV C-29 on 16th December, 2015 marked the 50th Launch from this soil. By now we have launched 67 launch missions and 466 sounding rockets from SDSC SHAR. Apart from this, Advanced Technology Vehicle (ATV), Re-Usable Launch Vehicle Technology Demonstrator (RLV-TD) were also launched from here.

Facilities and Activities:

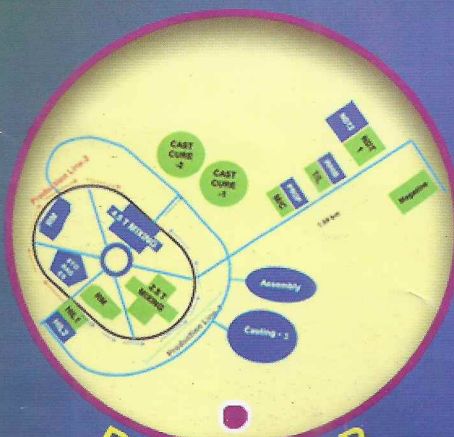
Besides the satellite launch facilities, SDSC SHAR has massive facilities for processing solid propellant and producing

SHAR PROJECTS

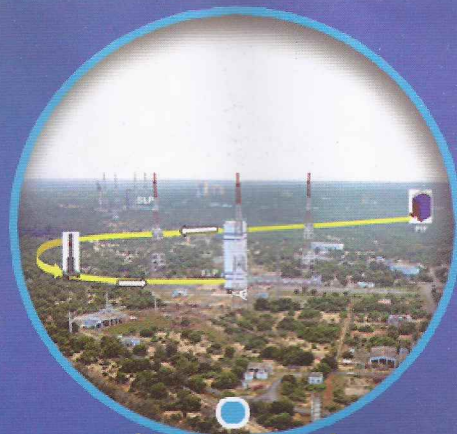
Gearing up for Future Decades



Project SVAB
To increase the launches from
SLP to 11 per annum



Project ASMP
To double the solid motor
production capacity at SPROB



Project PIF
To increase the launches from
FLP to 15 per annum

large size solid propellant boosters, and testing their flight worthiness. It has two satellite launch complexes, each equipped with liquid propellant, including cryo, storage & servicing, integration and launch facilities. A host of services like launch vehicle tracking, telemetry, telecommand, mission control, real-time flight data processing, satellite tracking and meteorology / weather forecasting facilities form part of the host of range instrumentation facilities. SDSC SHAR can process spacecrafts up to 5 ton class, while ensuring a rapid launch campaign even for the bigger size payloads. Spacecraft preparation facilities viz., SP-1A, SP-1B, SP-2A, SP-2B available on the ground and SP-3A (MST), SP-3B (VAB) are used for carrying out various tests on satellites with 1,00,000 class clean rooms.

Systems Reliability (SR) Entity carries out Quality Assurance & Reliability Analysis for the activities in the areas of Solid Motor Production & Testing (SMPT), Launch Complex Operations (LCO), Propellant Servicing (PS) and Range Operations (RO).

SDSC SHAR has initiated various projects to increase the capacity and the capability of launch base infrastructure for the operational launch vehicles, new generation vehicles and new technology initiatives conceived under Space Transportation Systems (STS). The development and realisation is addressed in all fields - right from production deliverables, test facilities, launch complex systems etc. With a clear foresight on the needs of Nation.

India's Space Vehicles Launched from SDSC SHAR



RH 560



SLV-3



ASLV-D3



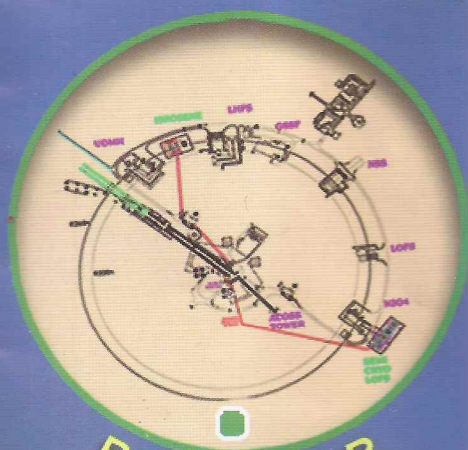
PSLV-C37



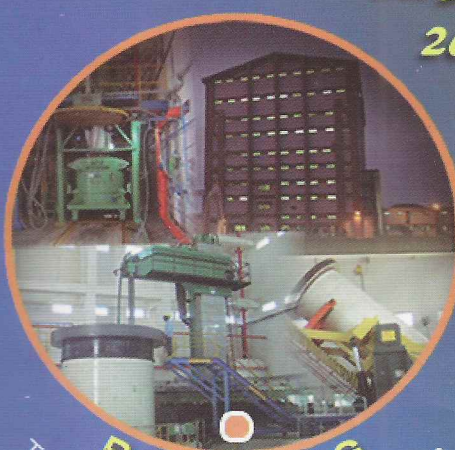
GSLV-F09



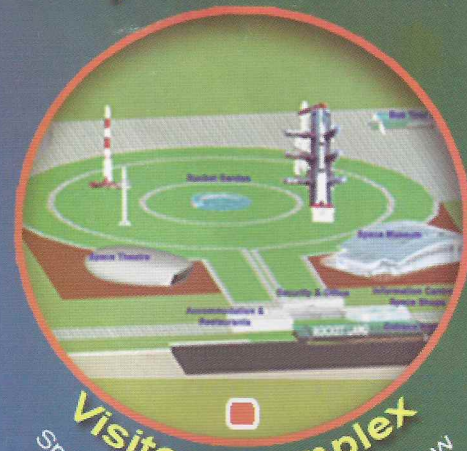
GSLV-MkIII-D1



Project ASLP
Augmentation of SLP
for Semi-Cryo Project



Project SPAG
To enhance the solid motor production
at SPP to more than double



Visitors Complex
Space Theme Park with Launch View
Gallery for 10000 visitors

Solid Propellant Production Plants

SDSC SHAR has two solid propellant processing plants for processing large size propellant grains of the satellite launch vehicles. The first plant, SPROB (Solid Propellant Space Booster Plant) was set up in the late 1970s for SLV-3 requirements and later got expanded to meet the solid propulsion requirements of PSLV and GSLV. This plant can process rocket motor segments upto 3.2 m in length and 2.8 m in diameter. The most significant one among the various motors processed at this plant is the first stage booster motor of the PSLV – a five segmented motor of 2.8 m diameter and 22 m length, weighing 160 tons with a thrust level of 450 tons. The same booster motor powers the first stage of the GSLV. A light weight Kevlar cased high performance upper stage solid rocket motor that powers the PSLV 3rd stage, is one of the advanced rocket motors produced here. The plant, with an original capacity of processing 500 tons of propellant, has been re-furbished and upgraded for production of another 400 tons to meet the immediate requirement of additional launches.

SPROB is being further augmented with additional facilities under ASMP (Augmentation of Solid Motor Propellant Production Plant) Project for processing around 1900 tons of propellant per annum to meet the future requirements of PSLV and GSLV.

For processing the segments of S-200 booster of GSLV-MkIII, the second plant - Solid Propellant Plant (SPP) was set up with 900 ton capacity per annum to process motor segments upto 3.2 m diameter and a length of 7.8 m. The length of S-200 motor is 22 m & weighs 207 tons and produces a 630 tons thrust at sea level. This is the third largest plant of its kind in the world. The processing facilities include hardware insulation & machining, casting, curing, inhibition & tilting, trimming, non-destructive testing and magazine etc. It has multiple mixing stations facilitating continuous propellant casting.

The main ingredients of the propellant produced at these plants are ammonium perchlorate (oxidiser), fine aluminium powder (fuel) and hydroxyl terminated polybutadiene (binder). The raw materials for the solid propellant processing are completely indigenous. Homogeneous mixing of these chemicals in a vertical mixer forms viscous



Grit Blasting and Degreasing Machine



Rubber lining of Solid Motor Segments



Mechanised transfer of propellant bowl



Second casting Facility



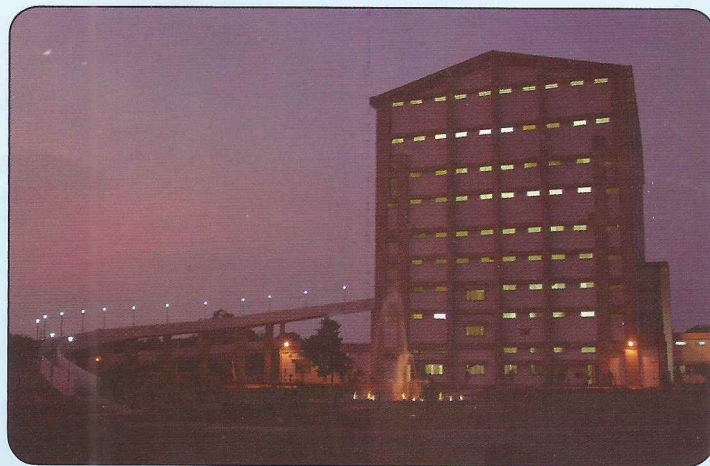
Magazine for Solid Motors

slurry, which is filled under vacuum into the rocket motor case. Prior to this, the motor case is prepared with a thermal insulation liner. The propellant slurry polymerises with the addition of curing agents and forms a solid mass having requisite mechanical properties. The rocket motor thus produced undergoes Non-Destructive Testing (NDT) using high-energy radiation for detecting any flaws like de-bonding, air bubbles, cracks and voids. Both plants are being augmented with increased capacity for meeting future requirements

Solid Motor Performance & Environmental Test Facilities

Rocket motors and their subsystems have to be rigorously tested and evaluated on ground before they are declared flight worthy. The different parameters of rocket motor like thrust, pressure, skin temperature, strain etc. are evaluated by testing them on ground under static conditions. SDSC SHAR has facilities for testing solid rocket motors, both at ambient conditions and at simulated high altitude conditions. Other test facilities include systems for the environmental testing of special purpose solid rocket motors, igniters, satellite propellant tanks etc., under vigorous conditions like vibration, shock, constant acceleration and thermal/humidity. S200 motor, the third largest solid propellant booster ever produced by ISRO, was static tested here and declared flight worthy.

Research & Development based static tests are conducted regularly at the recently established Aero-Acoustic Test Facility (AATF) for studying lift-off acoustics of newly developed launch vehicles & future launch vehicles of ISRO. As a result of these tests, acoustic suppression system using water at Second Launch Pad (SLP) was established and with the studies on Jet Deflectors, closing of the ducts of the Jet Deflector took place at SLP. Acoustic levels along the vehicle have been obtained from these tests and also the acoustic suppression using water has been demonstrated. All the motors related to Crew Escape System (CES) for future space programme are rigorously tested here. A new facility is established for visualisation of different flows using particle image velocimetry. All the instrumentation works viz., cooling of the satellites, air-conditioning units, generator & UPS power requirements are planned and implemented at SMP & ETF.



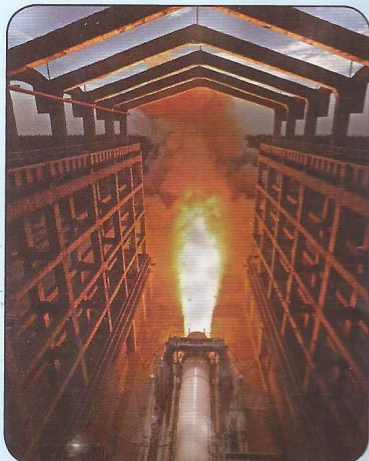
S200 Motor at Curing Facility



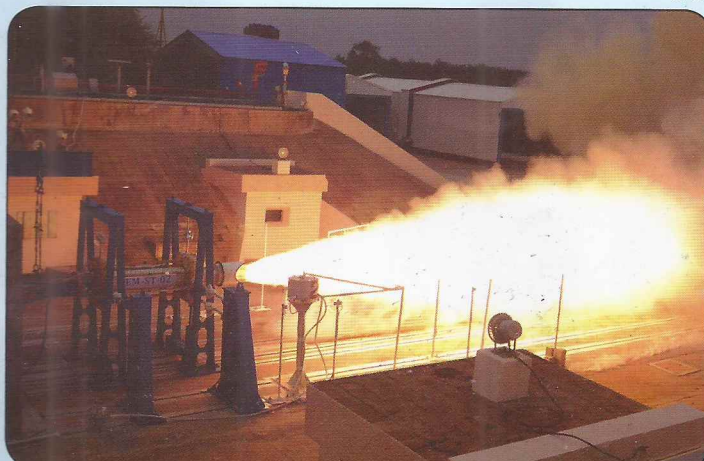
S200 Motor undergoing NDT at SPP



Non-Destructive Test Facility at SPROB



Static Testing of S200 Motor



Static Testing of Crew Escape Motors



Vehicle Assembly & Launch Facilities

SDSC SHAR has two operational launch complexes, each equipped with the necessary infrastructure for launching satellite into Low Earth Orbit (LEO), Polar Orbit and Geostationary Transfer Orbit (GTO). The same launch facilities were used for the first Indian Lunar Mission (Chandrayaan-1) and also the most popular interplanetary mission Mars Orbiter Mission (MoM). The launch complexes provide complete support for vehicle assembly, satellite preparation, fuelling, check-out and launch operations. Apart from these, facilities for launching sounding rockets meant for studying the earth's atmosphere are also available at SDSC SHAR.

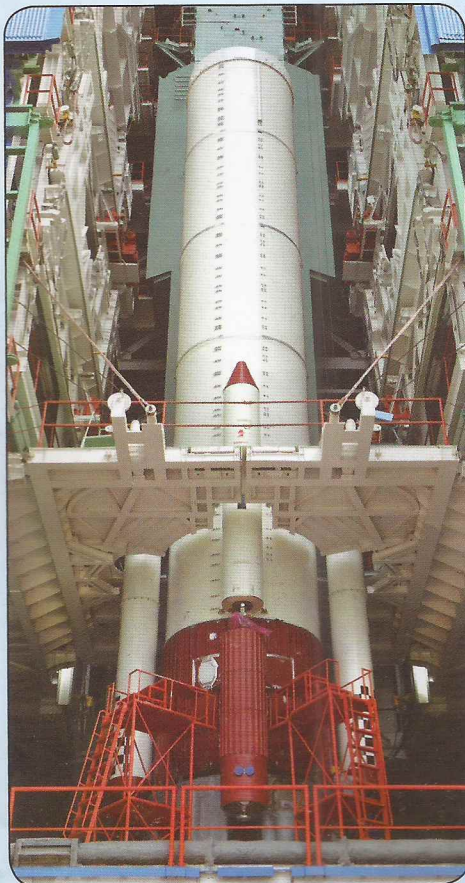
The individual stages of PSLV, GSLV with their subsystems and the spacecraft are prepared and checked out in separate facilities before they are sent to the launch pad for integration.

First Launch Complex

The first launch pad and its associated facilities were built in the late 1980s, primarily for the PSLV launch requirements. Later, they have been modified for the GSLV launch requirements. It was built on the concept of 'Integrate on the Pad', according to which, the individual stages of launch vehicle are brought from their preparation facilities, one after the other and integrated one over the other on the launch pad itself. The Mobile Service Tower (MST) equipped with foldable and vertically repositionable access platforms facilitates the integration activity. The spacecraft, which is checked thoroughly and fuelled at its preparation facilities arrives at the launch pad and gets integrated with the launch vehicle. A few hours before the launch, the MST is moved away from launch pad on a rail track. Separate storage, transfer and servicing facilities are available for earth storable liquid propellants such as UH₂ and N₂O₄, and cryogenic propellants such as Liquid Oxygen and Liquid Hydrogen. These propellants are fed into the onboard tanks through fluid circuits. The filling

operations, which are automated, are controlled and monitored from the Launch Control Centre (LCC), situated 6 km away from the launch pad. A few hours before the launch, the MST, which weighs about 3200 tons moves slowly to its parking place on 32 wheels, 8 nos. in each corner, on a twin rail track leaving the launch vehicle on the launch pedestal. Following the final remote checkout and fuelling operations, through the Umbilical tower which houses cable and pipe connections, exactly at 'T-0' of countdown the vehicle takes-off.

As the National requirements of the number of launches are increased, Government of India approved the construction of Second Launch Pad (SLP) at SDSC SHAR. Now, FLP is also getting further augmented with Pad Integration Facility (PIF) in another one year with which 12 to 15 PSLVs can be launched from the FLP itself. After the modifications carried out for PIF at FLP only the PSLVs can be launched from there and GSLVs can continue to fly from SLP.



Integration of PSLV-C42 at MST - FLP



Heatshield assembly at MST



Withdrawal of MST



PSLV-C42 on Pad



PSLV-C42 Lift-off

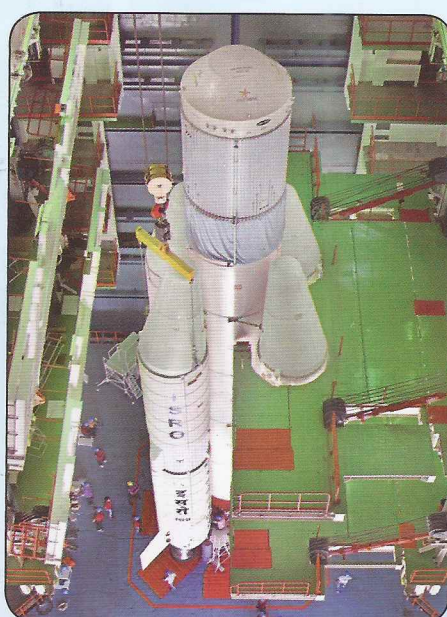
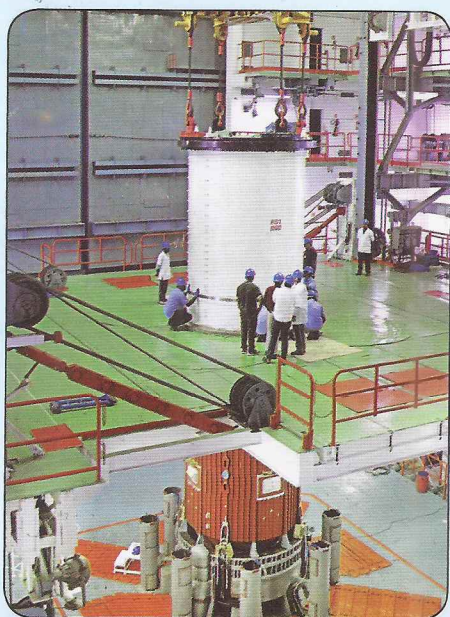
Second Launch Complex

In order to provide redundant facilities for launching the operational PSLV's, GSVL's and also to have quick turn-around time for launch, an additional launch pad with associated facilities was constructed. It was designed to accommodate, both the present PSLVs and GSVLs, and also the heavy launch vehicle configurations such as GSVL-MkIII. With the operationalisation of Second Vehicle Assembly Building (SVAB) SDSC SHAR will meet the growing national needs in terms of increased launch frequency. This massive facility (52 m x 70 m x 96 m) is three times bigger than the present VAB at SLP.

As per the, Integrate, Transfer and Launch (ITL) concept, based on which the new launch pad and the associated facilities are designed, the entire vehicle is assembled and checked-out on a mobile pedestal in the Vehicle Assembly Building (VAB) and then moved in vertical position to the launch pad on a twin rail track. This method reduces the pad occupancy and enables the vehicle to move back to

VAB for protection, in the event of any cyclone warning. The important facilities under SLP include, Launch Pad with an Umbilical Tower (UT) of 70 m tall and a Jet Deflector. Three swinging cum vertically repositionable platforms provide access to the vehicle while at UT. The Solid Stage Assembly Building (SSAB) realised for integration of first stage of GSVL-MkIII is modified and augmented for the first stage of PSLV and GSVL-MkII. This reduces the launch vehicle occupancy at VAB considerably leading to campaign of multiple missions from SLP.

VAB is 83 m tall, 40 m long and 32 m wide equipped with six sets of foldable-cum-vertically repositionable access platforms, a clean room and two cranes for handling loads Mobile Launch Pedestal (MLP) over which the vehicle is integrated will travel on a twin rail track of a kilometer length connecting the VAB and launch pad. A 16-wheeled bogie with four jacks would lift the launch pedestal and tow it to the tower on the twin rail tracks.



Integration of GSVL-F08 inside VAB - SLP



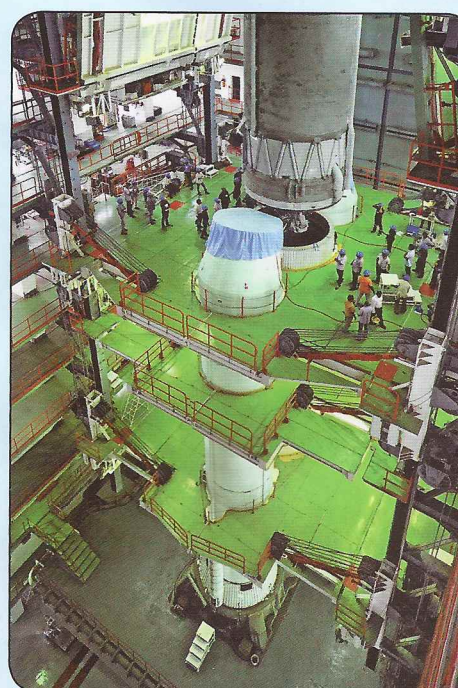
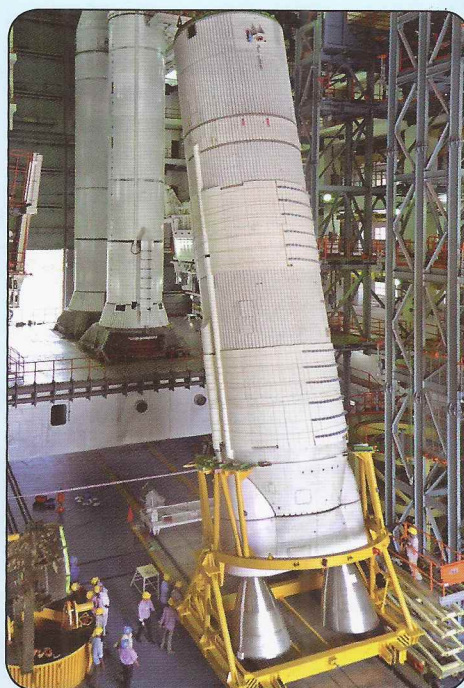
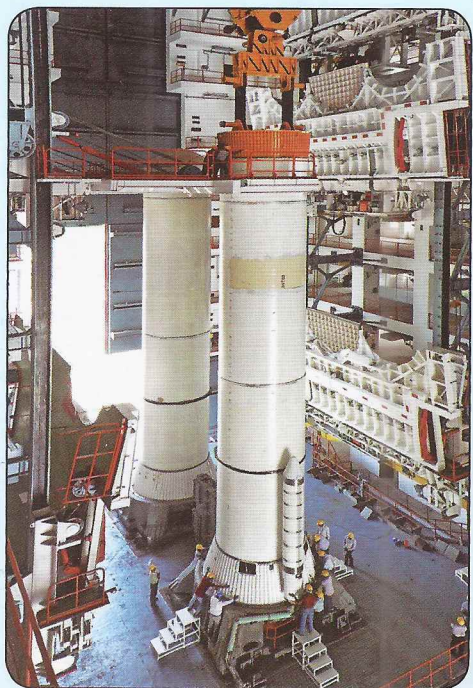


GSLV-F08 on its way for Launch



GSLV-F08 on Launchpad

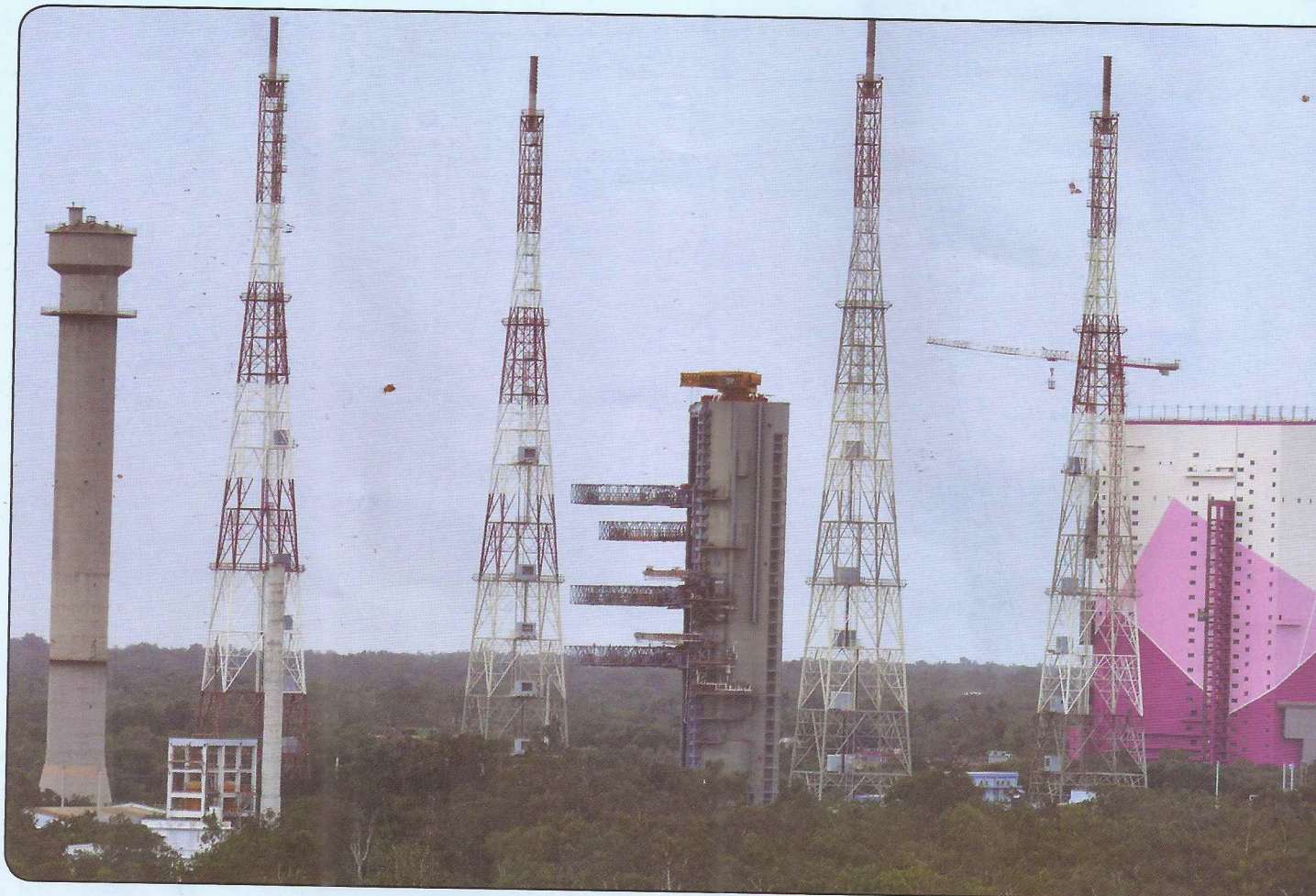




GSLV-MkIII-D1 Flight at SLP



GSLV-MkIII on its way for Launch



Liquid Propellant Storage & Servicing Facilities (LSSF)

A humble beginning was made with the establishment of earth storable propellant storages which eventually spearheaded further expansion as part of IREX – expansion project for PSLV/GSLV at FLP. Subsequent to erection, commissioning and operationalisation of FLP liquid, cryo and Gas systems, a mighty task for the establishment of Second Launch Pad, with state of art world class infrastructure has been setup with Integrate Transfer Launch concept. Also, bulk storage of N_2O_4 , UH25, MON & MMH has been added to meet the increased launch frequency.

LSSF Entity is primarily responsible for Propellant and gas servicing of liquid and cryo stages of PSLV, GSLV MkII and GSLV MkIII during countdown for all the launch vehicles. The entity will be conceiving, designing and realising the state of the art storage & servicing facilities for the earth storable, cryogenic propellants and the service fluids for the ISRO's launch vehicles' servicing. The process and instrumentation facilities are spread around the launch pads and the filling control system is located at 6 km away from launch pads.

LSSF consists of more than 25 facilities at various locations for propellant storage and servicing with following major systems

- Earth Storable Propellant servicing systems (ESPS) for handling liquid propellants such as UH25, MMH and oxidizers such as N_2O_4 and MON.



UH25 Storage Facility



N_2O_4 Storage Facility



Panoramic view of Second Launch Pad



LH₂ Storage Facility



Gas Storage Facility

- Cryo propellant systems (CPS) for handling Cryo stage propellants of GSLV MkII and GSLV MkIII. Since the boiling points of Liquid Hydrogen (20K) and Liquid Oxygen (90K) are very low, it is necessary to have super insulated storage tanks and pipelines for handling these propellants.
- Compressed Gas Storage Systems (CGSS) for stages and ground systems which require service fluids such as Nitrogen, Helium and compressed air for commanding the valves, purging the systems, thermal conditioning of the stage, etc.
- This facility is designed and realized for storage and charging of Gaseous Hydrogen upto 400 bar and is the first of its kind in SDSC SHAR and second in ISRO India, wherein GH₂ is handled at high pressures upto 400 bar. The criticality in design of this system lies in addressing the safety hazards associated with Gaseous Hydrogen especially at high pressures.
- Instrumentation & Control Systems (ICS) for remote filling of propellants during launch countdown.

LSSF is also responsible for Operation of Pneumatic servicing Systems, Receipt and Storage of propellants and cryo fluids at launch pads and bulk storage, Gas cylinder qualification in Gas Cylinder Test Facility, Safety relief valves testing, Calibration of process instruments, Calibration of mass flow meters and Propellant / gas analysis in Cryo & earth storable propellant analysis lab.

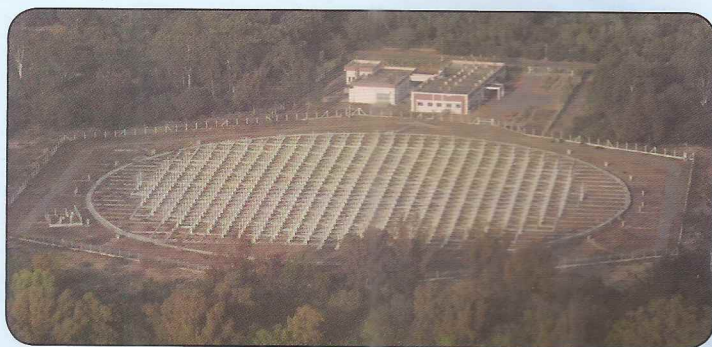
Range Operation Facilities

The Range Instrumentation facilities comprise tracking, telemetry and telecommand systems. High precision radars track the launch vehicle. The vehicle position information is instantaneously computed in real time from the tracking data and is used for evaluating the performance of the vehicle. The performance data of various systems of the vehicle is acquired by telemetry ground stations. The Mission Control Centre (MCC), situated about 6 km away from the launch complex, coordinates and conducts the launch operations during the countdown phase till the injection of the satellite into orbit. Thereafter the control is taken over by the Master Control Facility (MCF) located at Hassan. The MCC is linked to all the ground stations through communication links for voice and data transmission. The launch preparations on the vehicle are monitored from the MCC using a multi-channel closed-circuit television system. For meeting the requirements of GSLV-MkIII, a host of new facilities, including radars, optical tracking systems, telecommand system, mission control centre, real-time computer network, a wind profiler radar, etc., have been added. Multi Object Tracking Radar (MOTR) is established with indigenous technology for tracking of the launch vehicles, spacecrafts in orbits, aircrafts and Space Debris.

The well equipped safety team implements the range safety policies and regulations & monitor and takes care of all safety aspects of the range, ensuring foolproof safety of personnel and equipment involved, in a very commendable manner.

Dedicated Meteorological Facilities

The well equipped meteorological observatory provides pinpointed forecast of weather, at regular intervals during launch campaign and during countdown. Wind profiler radar has been established to augment the MET facilities. With instrumentation available here thunderstorms can be predicted accurately. The Doppler weather radar at Sriharikota and the MST Radar near Gadanki (about 100 km away from SDSC SHAR) also provide data for weather forecast. Upper wind measurement (up to 20km height) is carried out using balloon technique. Besides the radar tracked data, indigenously developed GPS-radio sonde (GPS-RS) technique is also used for wind measurement. The data is used for the 'day of launch wind biasing'. Numerical weather prediction technique is adopted for precise weather forecast.



Wind Profiler



Mission Control Centre (MCC)



Inside Mission Control Centre



PCMC Radar



Multi-Object Tracking Radar (MOTR)

Demonstration of Advanced Technologies

Keeping in view of the Nation's future requirements, critical technologies are developed and advanced vehicles like Advanced Technology Vehicle (ATV) and Re-Usable Launch Vehicle (RLV-TD) are successfully flight tested here

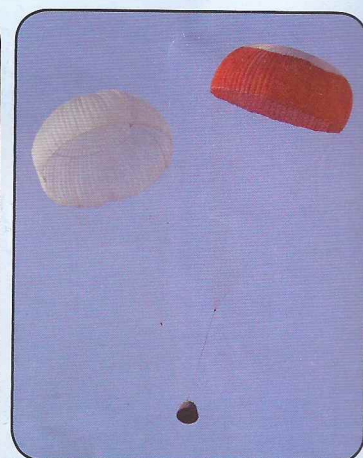
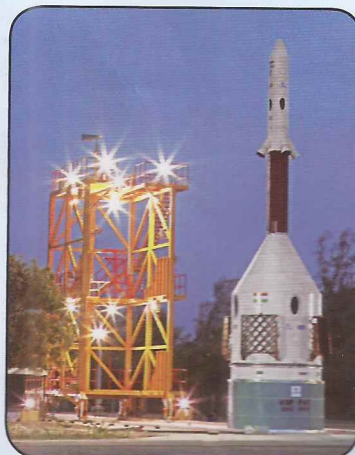


Advanced Technology Vehicle (ATV)



Re-Usable Launch Vehicle - Technology Demonstrator (RLV-TD)

Crew Escape System Validated



Crew Escape System plays a crucial role, which disengages and takes the Crew module to a safe distance in the case of emergencies for safe guarding the Crew. A Pad Abort Test was successfully conducted at SDSC SHAR on 5th July, 2018.

Public Outreach Programme

To impart awareness on space programmes to the student community and general public, a Space Museum is established during 2015 at SDSC SHAR. It consists of three main halls, each one with a theme. The first hall is on "Astronomy & Rocketry" the second hall on the "Spaceport of India" (SDSC SHAR) and the third hall on "Space Applications" respectively, on the mezzanine floor of the first hall flight components of various systems are displayed. The museum is open to public on all working days. The students from all states of country visit SDSC SHAR and get enlightened on space science and research activities.

World Space Week Celebrations are organised during 4th-10th October of every year to enhance the awareness of Indian Space Programme in public and also for igniting and inspiring the young Indian minds for the development of the country through space research. During the year 2017 SDSC SHAR celebrated at 21 venues covering the states of Andhra Pradesh, Telangana, Tamilnadu & Odisha.



Space Museum



Sriharikota - A Birds Paradise